

**U.S. DEPARTMENT OF COMMERCE
National Technical Information Service**

AD-A032 223

Economic Recovery from the Effects of Thermonuclear War

Russ Corp Santa Monica Calif

22 Aug 61

✓
3328123
ADA032223

ECONOMIC RECOVERY FROM THE EFFECTS OF
THERMONUCLEAR WAR

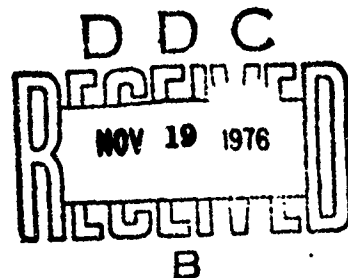
S. T. Winter, Jr.
Economics Department
The RAND Corporation

P-2416

August 22, 1961

*Statement presented to the Military Operations
Subcommittee of the Committee on Government
Operations of the House of Representatives,
Eighty-Seventh Congress, August 7-10, 1961.

Copy available to DDC does not
permit fully legible reproduction



Reproduced by

The RAND Corporation • Santa Monica • California

The views expressed in this paper are not necessarily those of the Corporation

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22904

DISTRIBUTION STATEMENT A

Approved for public release;

ECONOMIC RECOVERY FROM THE EFFECTS OF THERMONUCLEAR WAR

by

Sidney G. Winter, Jr.

Presented to
House of Representatives
Military Operations Subcommittee
of the
Committee on Government Operations
August 7-10, 1951

DATE	TIME	BY
SEP 11 1951	10 00 AM	...
DISPATCHED, TELETYPE UNIT		
FILE	APPROV	
A		

Mr. Chairman, discussion of civil defense over the past few years has been focused primarily on the problems of protecting the population from the various effects of nuclear weapons -- in particular, from radioactive fallout. This emphasis has been natural, since it is obvious that other problems of national recovery from a thermonuclear war are quite irrelevant unless the question of the feasibility of immediate physical survival can be answered in the affirmative, and it is quite likely that other problems can be handled if immediate survival can be assured. Nevertheless, as this committee stated in its report on last year's civil defense hearings, immediate survival is not enough. Unless the survivors of a war could escape death from starvation, exposure, and disease, and then go on to rebuild the nation, their "survival" would have little meaning. The possible obstacles to recovery resulting from the effects of the war on the physical environment in which recovery must occur will be discussed in the testimony of Dr. Mitchell and Dr. Hill. I have been asked to discuss the economic aspects of the recovery problem. There are, also, important social, political and psychological aspects, which I, as an economist, am not qualified to discuss in detail. But I will mention them when they impinge on the economic issues in an

important way. Owing to the complexity of these problems, and to the fact that many of them are very inadequately understood, I can do no more than provide a rough orientation on the subject.

Before I proceed I would like to say that I am speaking as an individual, not as a representative of The RAND Corporation or the U.S. Air Force. The views I am presenting are my own personal views, but I should mention the fact that much of my statement is based on information developed by my colleagues, and by individuals in other research organizations and in the government. This is a necessary consequence of the fact that I am presenting a general survey and orientation in the whole problem of economic recovery, rather than a detailed examination of any specific sub-problem.

Let me begin by trying to give a reasonably complete outline of the whole problem of recovery from the effects of thermonuclear war, to emphasize its complexity and to provide a framework for any discussion of the economic aspects of the problem. First let me set forth the major questions to which we would like to have answers.

CHART I

If the United States is involved in a thermonuclear war,

~~(1)~~ Can population losses be held essentially to those caused directly by the war?

~~(2)~~ Can the nation recover its prewar achievements in

- a) political organization,
- b) human welfare
- c) production?

The first question may be regarded as asking whether the sorts of casualty estimates that are conventionally made -- the losses from blast,

thermal, and radiation effects, and the long run medical consequences of radiation -- are really the whole story, or whether they yield a substantial underestimate of the population losses resulting from the war. Note that I said substantial, and I mean substantial in comparison with the war itself. It is quite possible -- in fact I would say it is virtually certain -- that factors such as disease, starvation, and a lower general standard of life will produce effects on the population that are large by the standards of peacetime. The question is whether they are large in relation to the direct consequences of the war, since policy choices are unlikely to be much influenced if they are not. Of course, if the difficulties of the recovery problem are to be judged in comparison with the consequences of the war itself, it goes without saying that those consequences must themselves be judged. It is important not to confuse the statement that recovery is feasible with the statement that the consequences of the war are in any sense "acceptable." In logic, though probably not in fact, recovery might be feasible after a war whose consequences were totally unacceptable.

The second question goes beyond mere physical survival. It asks whether the society that emerges from the war can recover to the point where, judging by the standards of our present relatively free and comfortable existence, it would be an acceptable place to live. Can democracy survive? Can the moral values of our society survive? Can the economy recover to the point where something approaching our present standards of living are possible? Will the psychological scars produced by a nuclear holocaust make a relatively normal and happy existence impossible? Many persons who are skeptical about the value of civil defense are troubled by these questions, rather than by any issues relating to the technical

performance of shelter systems. Their concern is justified, for, over much of the range of possible wars, the answers to these questions are far from obvious. The issues are too complex to be fully understood, and consequently there is no possibility of providing answers that are beyond reasonable challenge. This does not mean that attention to these questions, and research devoted to answering them, is without value. When decisions are made on important issues of national security policy in a world in which nuclear war is an ever-present possibility, some answers to these questions are necessarily implicit in the decisions made. By giving attention to these problems, we can at least avoid basing our decisions on answers which reflect some gross misconception about the workings of our society. But no amount of research is likely to alter the fact that decisions will finally have to be based on a large measure of faith in, or skepticism about, the basic strength and resiliency of the people and institutions of our nation.

Continuing now with the outline of the problem, let us examine the range of situations covered by the phrase "If the U.S. is involved in a thermonuclear war." The range of possibilities is wide.

CHAPT II

The Range of Situations

Differences in

- A. Military and civil defense postures
- B. Circumstances of outbreak of the war
- C. Strategies

CHART III

Produce Different levels of

- D. Casualties
- E. Destruction of wealth
- F. Organizational breakdown
- G. Postwar defense burdens
- H. Postwar assistance or interference by other nations.

The military and civil defense postures of potential combatant nations obviously set the basic context within which the whole problem must be examined. Since these can change significantly in rather short periods of time, almost every statement that is made must have the time period of its alleged validity attached before its validity can be judged. But it is much simpler to refer vaguely to what is likely to be true for the next few years.

I should mention that throughout my talk I am neglecting some important possibilities in the range of military postures, particularly the possibility that bacteriological and chemical weapons might play a significant role. The reason is simply stated: ignorance. I believe this ignorance is widely shared, and I doubt that the possible effects of bacteriological and chemical weapons are known with sufficient accuracy to permit an evaluation of how important their effects might be on the recovery problem. Next, there is the important issue of how the war starts -- whether, for example, it starts with a surprise attack, or as a result of some crisis leading one or both sides to preempt, as a result of escalation from a limited war, or any of several other ways. How the war starts has important implications for the amount of warning the population is likely to receive and for the amount of

preparation that can be accomplished in the last weeks, days or hours before the war. In addition, I should mention that the time of year the war occurs has a great bearing on recovery problems. It affects, for example, the possibilities for evacuation, the fate of homeless refugees, and the level of food stocks. The enemy's choice of targeting strategy, whether he launches attacks on population, on strategic forces only, or attempts to paralyze our economy temporarily or permanently, will obviously pose quite different problems of recovery. I will provide some indications of just how different the problems can be later in my talk.

Given almost any specifications of the consequences of the war, it is possible to construct plausible assumptions about the war itself that will produce those results. At least, this is true if one considers the possible changes in military postures and strategic doctrines that could occur between now and, say, 1970. The important conclusion to be drawn is that it is almost meaningless to ask whether given civil defense preparations "will work" or whether recovery "is possible." It is clear that within the next decade or two, wars could occur where any particular type or degree of preparation might be (1) Not needed. (2) Helpful but not essential. (3) Essential for the avoidance of substantial additional population losses and for social recovery. (4) Worthless, because hopelessly insufficient.

In deciding whether any given measure of preparation should be undertaken, we have to ask whether making the preparations will affect the probability that they will be needed. Depending on the measure and the way it is carried out, I believe that this effect can go either direction. If it is of substantial magnitude, this consideration will probably dominate. Otherwise, we must ask whether the measure is a good buy considered as

insurance. This means asking whether the range of situations for which the measure would be helpful or essential is sufficiently broad to justify the expenditure. It does not mean asking whether the measure will be valuable in every conceivable war that could occur, or whether a war in which the measure would be valuable is certain to occur; no insurance policy pretends to cover every contingency.

It is clear, also, that the relative balance between surviving population and surviving productive capacity has a very important bearing on the problem of economic recuperation. If, for example, the enemy concentrates his fire primarily on military targets and we have neglected to provide fallout protection for our citizens, a situation could easily arise where the surviving wealth per capita was greater than it is now, although there would remain, of course, the problem of organizing the surviving wealth and human resources into a viable economy. If, on the other hand, we have an extensive system of blast and fallout shelters, and the enemy attacks our cities, much of our population may survive the immediate effects of the war, but the destruction of productive capacity may make it difficult to support the survivors in the long run. Thus the relative importance of the problems of recovery may be inversely related to the level of direct population casualties in the war.

The great and possibly overriding importance of Point F -- organizational breakdown -- is, I believe, increasingly recognized by almost everyone who has looked into the economic aspects of the recovery problem in any detail. Many of the important unsettled questions relate not to the physical and technological feasibility of taking constructive actions which will lead to full recovery, but whether there is sufficient reason to believe that

capabilities will exist for recognizing the possibilities and taking the actions. If one speculates on how a complete failure in the recovery effort might occur, the picture one develops is of a situation where the effectiveness of the federal government and many state governments is greatly diminished, the banking system disrupted, most surviving firms are bankrupt, electric power and water supply systems are severely damaged, and the transportation network broken in many places -- and where few survivors have the responsibility, authority and plans to do anything about it. Such a situation could arise even if the physical feasibility of recovery were beyond question. The efforts that are being made to assure continuity of government and of management of firms, to preserve the banking system, to assure solvency, and so on, are clearly a very important part of our preparations.

The expected character of the international environment after the war -- is also extremely important and constitutes a major source of uncertainty in evaluations of the recovery problem. Most such evaluations, including my own, assume that attempts to support military forces will not be pushed to the point where serious obstacles are placed in the way of reorganization and reasonably rapid recuperation. It is reasonably clear that the forces do not have to be very large, by present standards, before their support becomes a serious obstacle to recovery. Thus the assumption that the nation will recover rather than rearm appears to involve a more fundamental assumption that for one reason or another, a war would produce a substantial and fairly permanent reduction in the external threat. I do not find this assumption implausible, but its existence should be noted.

The question of our economic relations with other nations after the war will also be important. If, for one reason or another, nations untouched

by the war are unwilling or unable to trade with us, very heavy damage to particular industries may make rapid recovery impossible even if many other industries go relatively untouched. But if we can trade with nations that escape involvement in the war, the problem of imbalance, that is, of "bottlenecks," in our surviving economy will be greatly alleviated. Very severe damage to any particular industry will then be of relatively little significance as compared with the total level of destruction of our economic resources. The prospects for recovery would be further improved if, in addition to trading goods of which we have a relative surplus for those that are scarce, we could finance additional imports by drawing on our gold stock and liquidating our investments abroad. We might have up to about \$25 billion to draw on from these two sources, although the feasibility of actually making use of a large fraction of that amount is questionable. It is conceivable that we might obtain assistance from other nations in our reconstruction effort. But the availability and significance of help from all these sources are obviously dependent, first, on the pattern and level of destruction in the rest of the world, and, secondly, on the postwar international political situation. The latter presumably depends to a considerable degree on our success in limiting damage to the United States, and securing a relatively favorable military outcome is likely to be conducive to success in the recovery effort.

With the questions that need to be answered and the wide range of possible situations in mind, let us now turn to the problem of recovery itself. It is quite useful to divide the recovery period into three time phases, each of which has its distinctive problems:

CHART IV

The Three Phases of Recovery

- A. Survival - Minimize population losses
- B. Reorganization - Achieve economic viability
- C. Recuperation - Restore economy and basic institutions.

I have indicated for each time phase the principal domestic problem facing the nation. In the survival period, which begins with the first attack and extends to a few months after the end of the war, the principal problem is that of minimizing the short run population losses imposed by the war and the resulting destruction and disorganization. Not only are there likely to be millions of non-fatal casualties from the blast, thermal and radiation effects of nuclear weapons who will die if medical care is not provided, but additional millions will be threatened (with varying degrees of immediacy) with death from exposure, disease, thirst, and starvation. The resources and organization to meet these threats to the population will necessarily be drawn almost entirely from areas that have escaped damage, or have been damaged only slightly. And the adequacy of those resources and organizational arrangements will depend almost entirely on what pre-attack preparations have been made to meet these tremendous problems. Dispersed and protected stockpiles of medical supplies, food, and other survival items, plus realistic organizational arrangements and large numbers of well-trained civil defense workers, will make effective action possible. Without these preparations, millions will die unnecessarily.

During the reorganization period, the major problem is that of achieving a viable economic system. I will speak on this in detail in a moment. Once viability is achieved, the emergency will be over and the task facing the

nation will be that of restoring a high standard of living in a free society in which our basic values are preserved. Many difficult problems which can be postponed during the emergency must then be faced. For example, a permanent unraveling of the spectacular tangle of property rights created by the war will have to be accomplished somehow, hopefully in a way which spreads the economic costs of the war over the surviving population in a relatively equitable fashion. Adequate preparations will, of course, make this much easier.

In attempting to reach some fairly definite conclusions as to the ability of our nation to cope with the problems posed by all three of these phases of recovery, we have to examine a very broad range of considerations. We have to look at the physical and technological side of the problem -- the question of what level and pattern of destruction of wealth occurs, what the technological possibilities are for exploiting the surviving wealth, how much of our farm land is contaminated with Strontium 90, whether the ecological effects of the war are likely to have major effect on agriculture, how the general health of the population is likely to be affected by the levels of radiation in the environment and by the austerity in such things as diet and medical care that is likely to be necessary, and so on.

Then we have to consider the organizational side -- what private and public agencies will undertake the tasks of fire fighting, rescue, maintenance of law and order, medical care for the injured, control, protection and distribution of inventories of food and other necessities, and so on. How will the economy be run during the reorganization and recuperation periods; what sorts of controls will be necessary and desirable; what measures can be taken to prevent the enormous confusion of property rights and debtor-

creditor relations from interfering with the restoration of essential production? And so on through a much longer list of questions. These are the types of questions that are treated, in general terms, in the National Plan for Civil Defense and Defense Mobilization. But, as this committee has pointed out, that document does not relate the delegations of responsibilities it makes and the general objectives and policies that it sets forth to any assessment of the capabilities of the designated agencies to achieve the objectives and carry out the policies. Finally, we have to consider the broad problem of the social, political and psychological impact of the war. Will the shock of the war so derange people that they will be incapable of constructive action on behalf of themselves and others? To what extent will an extensive delegation of responsibilities in the civil defense to state and local governments lead to actions consistent with the national interest when these may be in sharp conflict with the interests of the smaller political units? Will survivors be so overcome with grief and apathy, even when the immediate threat to their survival has passed, that they will be unwilling to make the effort to restore the economy? Will those survivors in relatively untouched areas willingly bear the burdens of supporting those who are less fortunate? Will the psychological scars produced by events in which millions are killed, additional millions injured and living in an environment which has become distinctly more hostile to human life, preclude any meaningful recovery in terms of human welfare? As an economist, I can hardly presume to provide definitive answers to this last series of questions. I want to stress their importance, however, and to emphasize the fact that the relevance of all analysis of the economic problem hinges on the answers being relatively optimistic.

This concludes my survey of the problem of recovery. I will summarize it by saying that, for the full range of possible wars, we need answers to all of the important physical, technological, organizational, social, political, and psychological questions that arise in connection with each of the three major phases of the recovery process. And the answers should then be pulled together and integrated into the best comprehensive picture of what the various possible nuclear wars might mean to our nation that we can construct. Now as I mentioned earlier, it is clear that no amount of research will actually provide us with a picture that is very reliable. But I cannot refrain from commenting that, in my opinion, our knowledge is much less complete than it needs to be and could be. A good deal of competent and important work has been done, but it does not really scratch the surface of this vast problem, and there is, in particular, a definite need for a systematic and comprehensive re-examination of the whole problem.

This committee, I know, is familiar with the 1958 RAND Corporation Report, "A Study of Non-Military Defense." That study was reasonably systematic and comprehensive, but its treatment of many details and a few major problems was inadequate. On the other hand, the large number of other studies that have been done are relatively strong on details, but the integration provided by a comprehensive study is lacking. In general, there are too many unexamined mechanisms and interactions which might produce considerably greater problems of recovery than the work done so far suggests. These issues should be examined and the questions settled as conclusively as possible. A needlessly limited understanding of what the risks are, only increases the hazards we face by increasing the chances of seriously mistaken estimates of the losses a war would involve -- and either

underestimates or overestimates can increase the chance of a catastrophe.

Some of the work now underway will produce results in the near future which should result in a considerable increase in our knowledge. In particular, some powerful tools for analysis of reorganization and recuperation are being developed under the auspices of the National Resource Evaluation Center in the OCEM. Some results will be forthcoming from that source within the next six months to a year. I also understand that OCEM, in cooperation with the National Academy of Sciences, is fostering, in the universities and elsewhere, a larger research effort on the social and psychological effects of nuclear war, and on attitudes toward preparedness. Plans also exist for expanding the OCEM-supported effort at the Stanford Research Institute. Perhaps the rate at which our understanding improves will soon get substantially above the rate at which the problems get more serious and more complicated.

In the remainder of my testimony, I want to focus primarily on the problems of economic reorganization and recuperation and to suggest in general terms the reasons why an attitude of cautious optimism seems to be justified with respect to the ability of the nation to cope with these problems over a broad range of possible wars.

I will not discuss the economic problems of the survival period, which are mainly a matter of making effective use of inventories of food, medical supplies, and other necessities in order to meet the immediate threats to the surviving population. Assuming that this can be accomplished, the next question is whether production of the necessities of life can be restored before the inventories are depleted. Until this task of restoring production is accomplished, there is a continuing threat that the economic

system will go into a spiral of cumulative disorganization, a spiral which will come to an end only at a much lower level of economic life and with, in all probability, a much smaller surviving population. This threat arises from the fact that when people are unable to meet their minimum needs by the usual and socially desirable means of participating in the production process, they are likely to turn to unusual and socially undesirable means, such as foraging, plunder, and sterile trading in household goods. Eventually some form of social organization would be re-established, but that organization may be at the level of self-sufficient families, communities or regions. Starvation, disease and exposure would take a heavy toll of lives before such an equilibrium could be reached -- and when achieved, the United States would have a primitive economy. To avoid this outcome should be the chief goal of all preattack policies in the field of economic preparedness.

Restoring the production of food is obviously of prime importance in the process of achieving economic viability. Several studies of the effects of a thermonuclear war on agriculture have been made, and the general conclusion seems to be that the problems would not be critical, although they might under some circumstances be quite serious. The reason the problem would not be critical is that, because of the large agricultural surpluses we have accumulated, even a complete stoppage of agricultural production for a year or two would not threaten the survival of the population. Indeed, it appears that over most of the range of possible results of a war, the surviving food stocks would support the surviving population for well over two years. There would be time to take the measures and accomplish the tasks necessary to get production going again,

and to let radiation levels decline, to reorganize the patterns of production to minimize the problems created by long lived isotopes such as Strontium 90, and possibly to take steps to decontaminate farmland.

Without the period of grace allowed by the large surviving food inventory, the feasibility of avoiding famine would be very much in doubt.

Restoring agricultural production is by no means the only major problem of the reorganization period. There are other essential industries -- petroleum, for example, is needed for tractor fuel and for meeting minimum transportation and heating requirements. Transportation itself presents important and complex problems. Studies of these industries have been made, particularly at the Stanford Research Institute, and no impassable obstacles to recovery have yet been identified. However, I must emphasize again that the interactions among the various sub-problems have not been adequately studied. Further inquiry might change the conclusions substantially.

Rather than go into detail on the problems of restoring production in particular industries, I want to present some calculations which may provide some insight into why relatively optimistic conclusions seem to be so typical. The reason, basically, lies in the great productive powers of our economy. The fraction of the economy that must survive if the population is to be supported at austere but tolerable consumption levels is really quite small. The chart shows the percentages of 1958 capacity in various industries which would be required to meet austere consumption requirements for the entire 1958 population.

CHART V

Percent of Capacity Output Required in Various Industries
to Meet Austere Consumption Requirements
(Figures for 1958)

<u>Industry</u>	<u>Percent of Capacity</u>
1. Drugs, Medicines	54
2. Pulp and Paper	51
3. Textiles	45
4. Grain Mills	43
5. Tobacco Manufactures	43
6. Apparel	41
7. Leather	41
8. Meat Packing	40
9. Petroleum	40

The definition of "austere" for the purposes of this calculation is a level of real personal consumption expenditures per capita which is about two thirds of the present level, and just under the actual level of 1929. There are obviously many plausible possibilities as to the amounts of different goods and services which are to be included. The figures above reflect a particular choice, which took into account such things as the historical patterns of consumption at various income levels, modified to take into account the changes that have occurred in consumer tastes. Of course, comparative luxuries, like household appliances, have been cut back more severely than necessities like food. The figures presented are at the top of the list of manufacturing industries in terms of the percentage of

capacity required; the definition of capacity is not sufficiently unambiguous in agriculture and the service industries to make comparisons of this sort meaningful. The rest of the manufacturing industries are distributed as follows: In only ten industries would twenty to forty per cent of capacity be required, the remaining fifty-one are below twenty per cent.

The requirements for the output of the various industries were computed by the technique of input output analysis, and both the direct requirements for output delivered to consumers, and the indirect requirements generated by other industries are included. Thus the 40 per cent of petroleum capacity required includes not only the allowance for such things as gasoline for private automobiles, but also the requirements for tractor fuel needed to produce the food. The general conclusion is that for almost all industries under 50 per cent of capacity is needed to support the full population at about the 1929 level. Another way of putting it is to say that as long as the ratio of surviving capacity in most industries to surviving population is not much less than half the prewar ratio, support of the population at the 1929 level of consumption or better should be possible. This is the underlying reason why studies of particular industries generally reach optimistic conclusions -- destruction of capacity relative to population casualties has to be quite large before a situation is reached where the support of the survivors will constitute a serious problem. Relatively minor efforts at restoring damaged capacity or building new will generally suffice.

Let me now turn to the problem of what sort of ratios between surviving economic capacity and population might be expected to result from a thermonuclear war. The answer depends on the relative geographic concentrations of population and various types of capacity, on the enemy's choice of a

targeting strategy, and on the level of the attack. The influence of all of these factors is summarized in the series of charts I will now present.

(Figs. 1 - 6). The curves show the percentage of the particular resource that is contained in the indicated number of target areas, up to the point where the curve is getting quite flat. If a 10 megaton weapon made a direct hit on a "target area," a large fraction of the population of that target area would be killed, unless blast shelters were available. Also, the destruction of productive capacity would be essentially total. If fallout shelters were available for the entire population, and there were essentially no blast shelter available, the population curves may give a rough approximation to the casualties that would result if the indicated number of target areas were attacked. However, the approximation is probably very rough indeed. These curves cannot safely be used for the purposes of estimating casualties and damage from any particular attack, but they are very useful for getting a picture of the range of situations that may arise with respect to the balance between surviving resources and population.

The level of destruction of any particular resource when a given number of target areas are hit obviously depends on which target areas are on the list. The first two charts illustrate the different situations that arise with respect to the balance between population and survival industry. Survival industry is a broad industrial category including the industries that are important in meeting the basic needs of the population -- for example, food processing industries, medicines and medical supplies, apparel, fuels, and various industries that produce goods needed in repair of basic utilities. In the first chart, the concentrations are shown for the case where

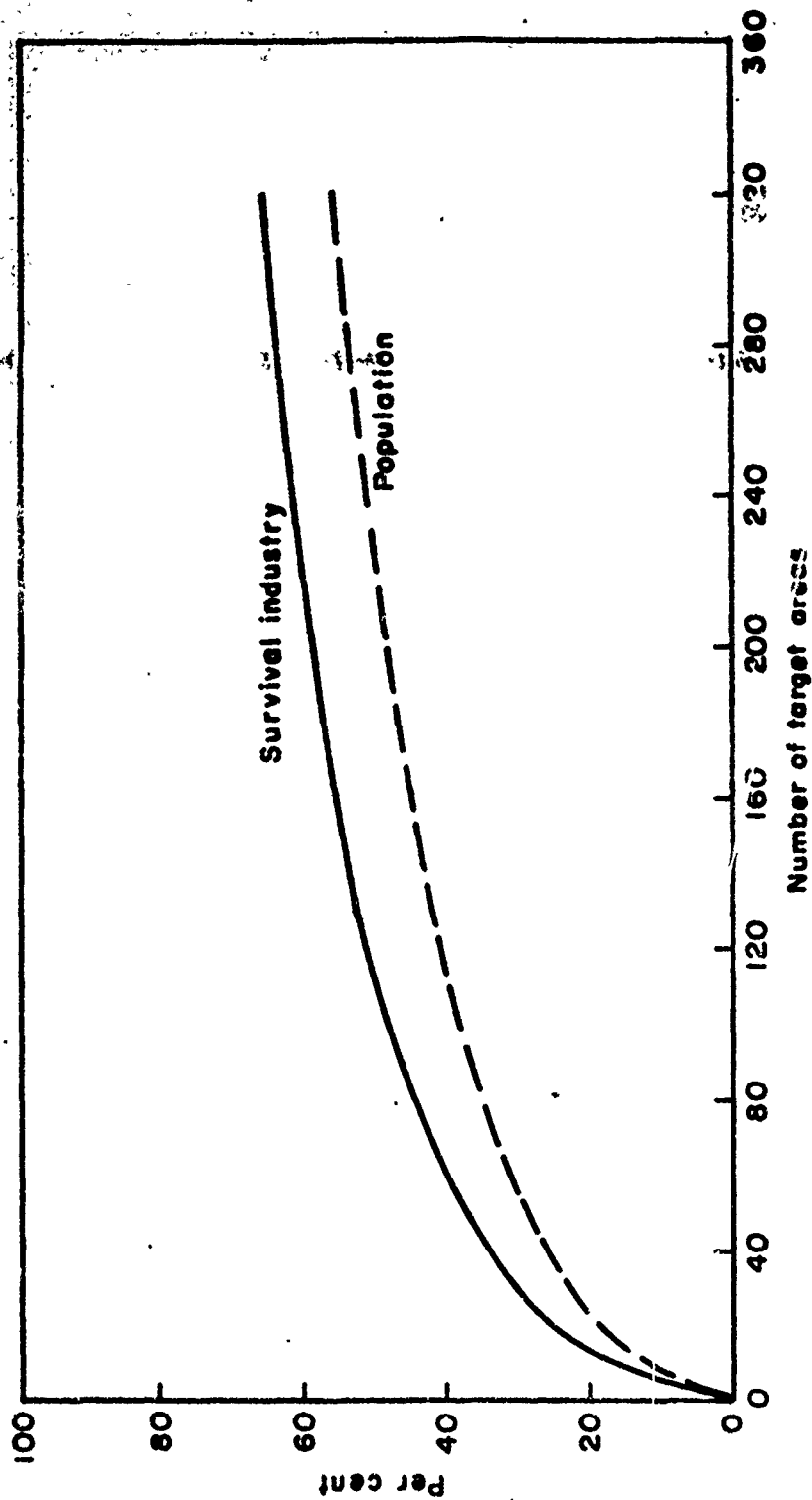


Fig. 1 — Concentration of resources — Population and Survival Industry

the areas are ranked according to population. The population curve shows, for example, that the 120 largest target areas in terms of population contain 40 per cent of the country's population. The survival industry curve shows that those same 120 areas contain about 55 per cent of the survival industry, in spite of the fact that the 120 areas were chosen for their high population rather than the amount of survival industry they contained. This illustrates the general tendency for industrial activity to be more concentrated geographically than the population.

The second chart (Fig. 2) shows the situation when survival industry, rather than population, is singled out as the target system. As might be expected, the result is that the amount of survival industry included in any given number of areas substantially exceeds the amount shown on the previous chart, while the percentage of the population is smaller. I want to relate this second chart to the conclusion I developed earlier, that the problem of supporting the surviving population is unlikely to be serious if the proportion between surviving economic capacity and population does not fall below about half its prewar value. The case where survival industry is specifically targeted is the worst case from the point of view of reducing that ratio -- unless, of course, the enemy also attempts specifically to avoid causing population casualties, which would be welcome. Examining the ratio between the proportions of the two categories outside any given number of target areas, we find that the ratio is about .75 at 40 areas, and at the right hand side of the chart the ratio seems to be stabilizing at around .40. Since, as was noted earlier the percentage of most industries required to support 1929 consumption standards is well

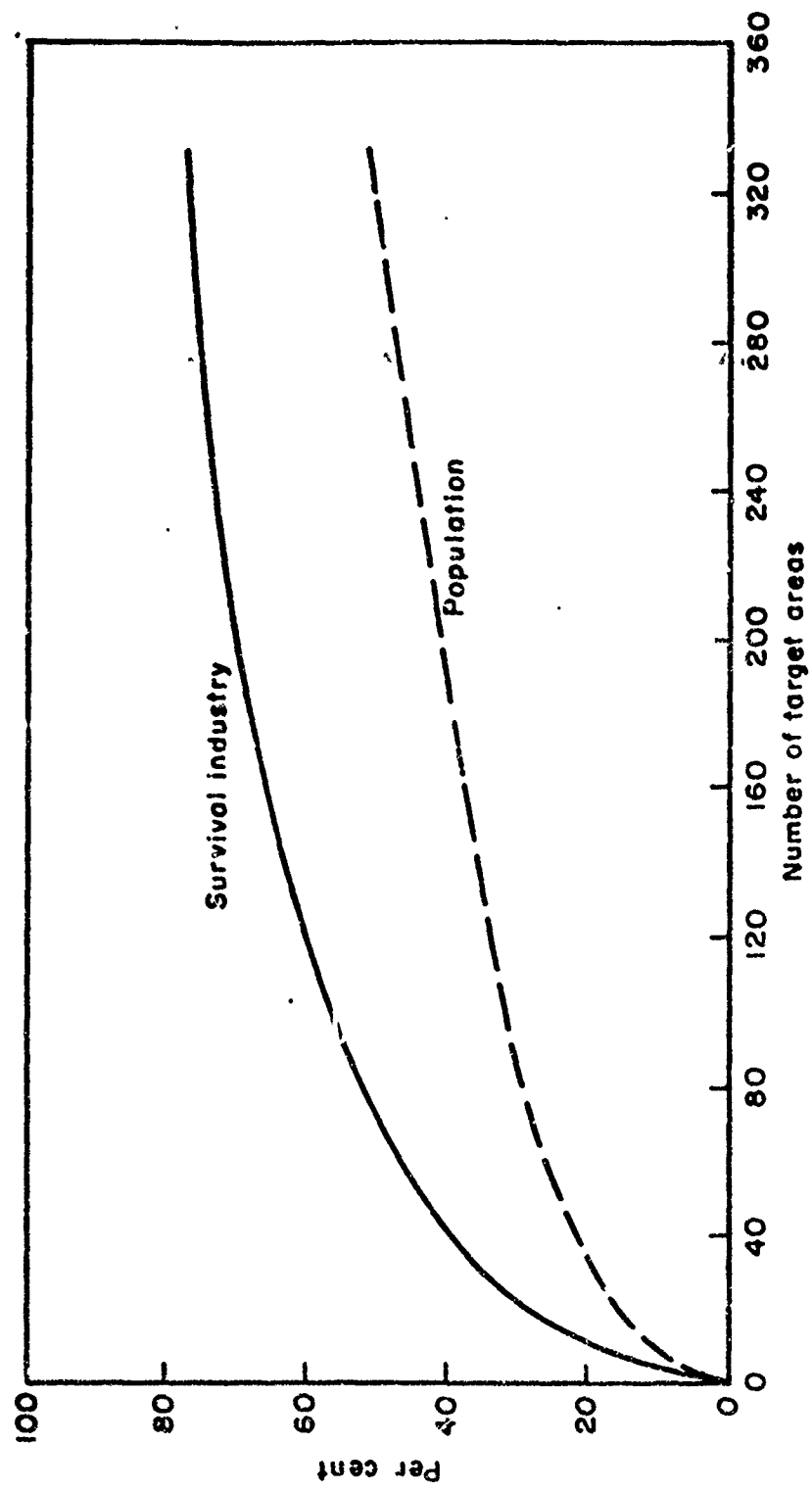


Fig. 2--- Concentration of resources — Survival industry and population

under 40, and since 1929 standards are a long way from threatening the survival of the population, it appears that enough capacity would survive to support the surviving population even in the worst possible case. It should be noted, however, that survival industry is an aggregate, and some industries would suffer destruction in greater proportion than the aggregate. However, surviving inventories of necessities should be more than sufficient to support the population until these severe bottlenecks can be alleviated.

The next two curves (Figs. 3 and 4) show the relative concentrations of population and of a group of industries needed in recovery and support of military forces. The group contains mainly heavy industry -- the primary metals, machinery, industrial chemicals, aircraft, and so on. We find that this group is more concentrated than survival industry. In particular, when target areas are ranked according to the amount of recovery and military support industry they contain, it turns out that something like two-thirds of the total is in the first hundred areas. Support of military forces would be very difficult relative to the problems of survival, let alone in absolute terms. Also, this result indicates that recovery might get off to a slow start as a result of relatively heavier destruction in the industries required for the production of new capacity. This is in line with the conclusions of earlier studies.

As a last comment on the concentration of resources, I want to mention the fact that severe bottlenecks can easily be produced in certain industries if the enemy chooses to attempt this. A good illustration is petroleum refining. The first chart shows that concentration of capacity in this industry is about the same as the concentration of population, when the areas are ranked by population. A dramatic change occurs when petroleum refining is singled out. Over 90 per cent of the industry is in about 100

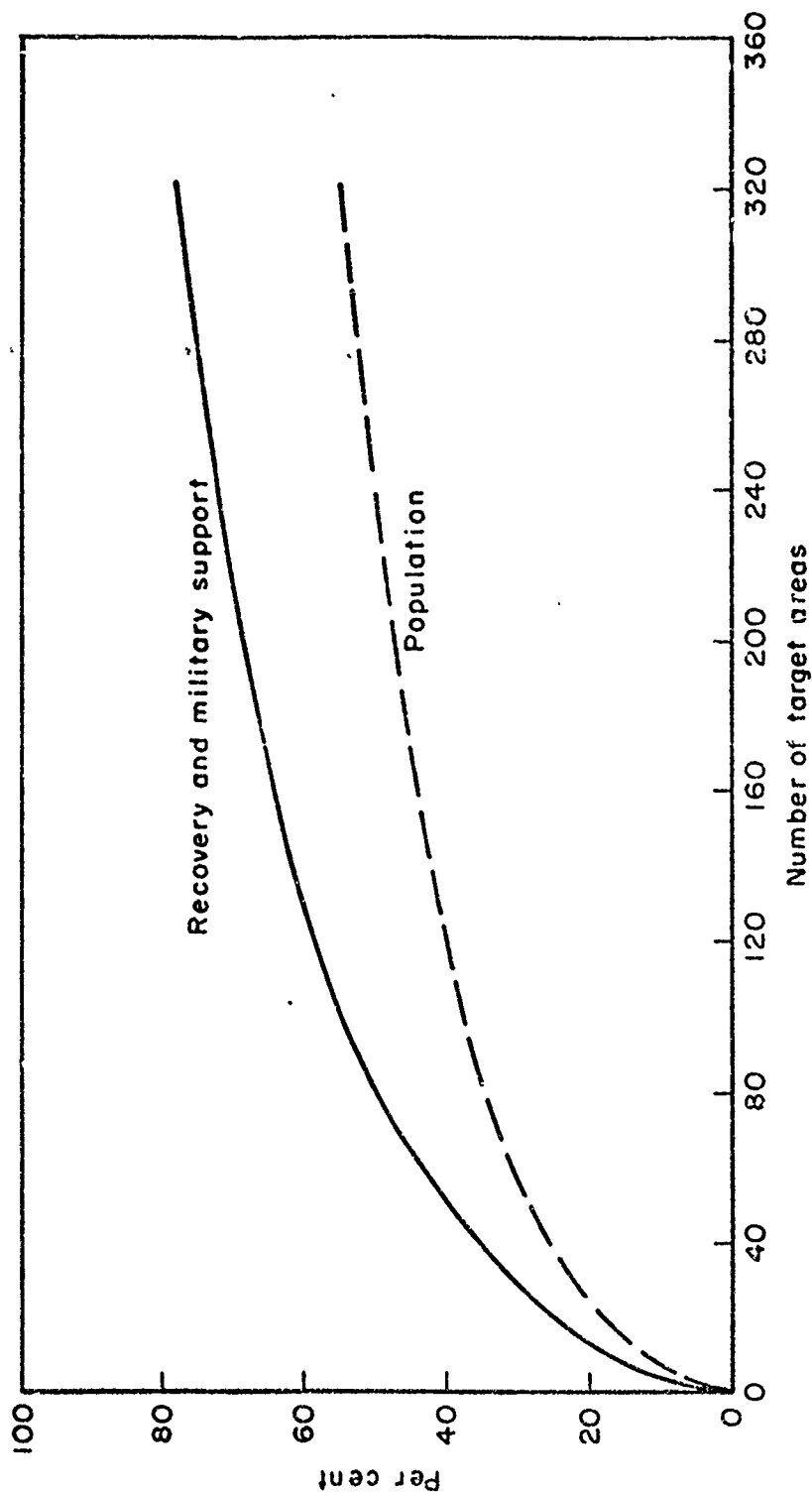


Fig.3 — Concentration of resources — Population and
recovery and military support industry

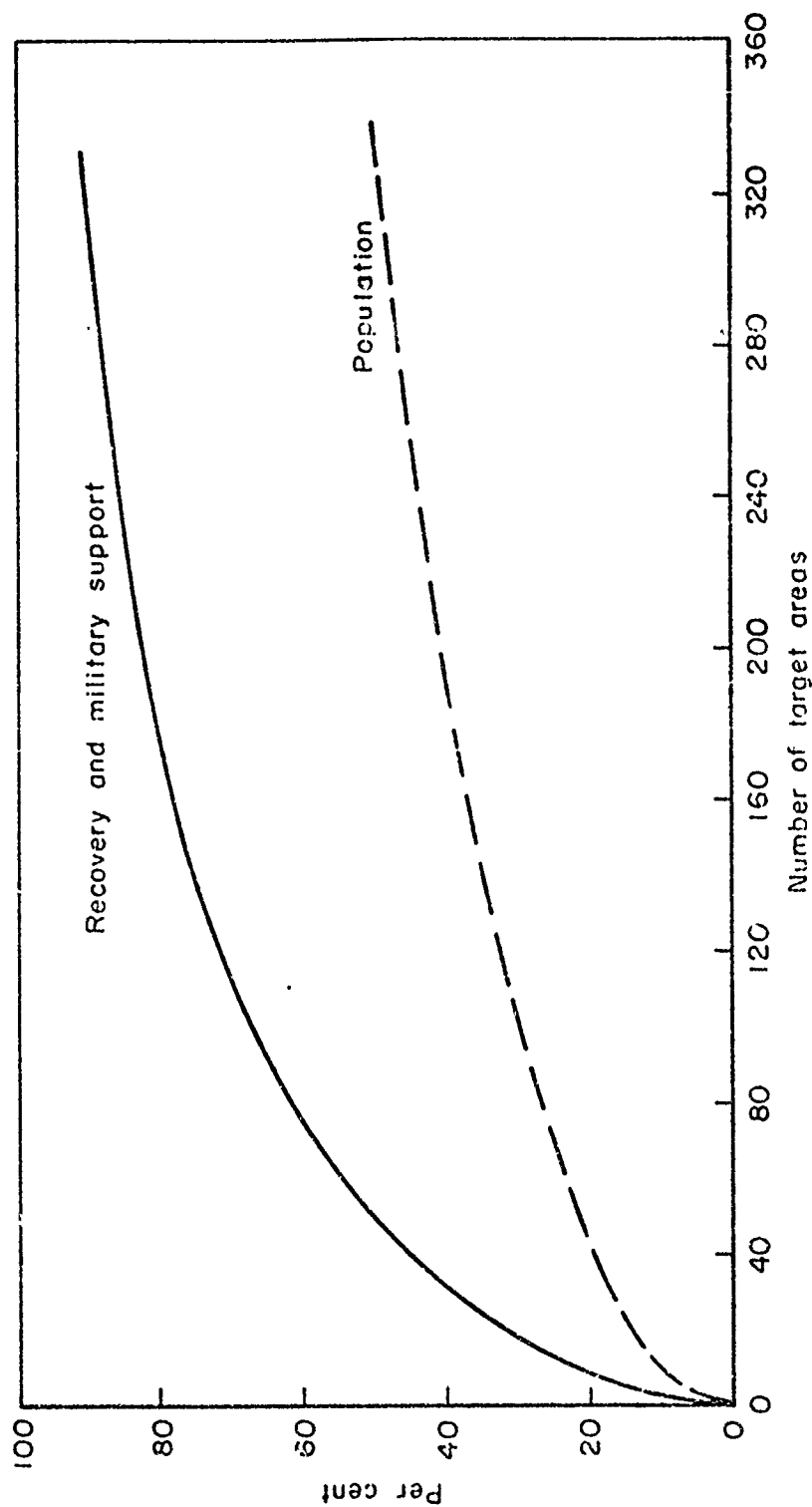


Fig. 4 --- Concentration of resources --- Recovery and
military support industry and population

areas, and 12 1/2 per cent of the population. Given the extent of our dependence on petroleum for tractor fuel and transportation, this is disturbing. However, the significance of this sort of result can be exaggerated. A heavy attack on a specific, concentrated target system will generally result in significantly less total destruction than one aimed at the population or the economy in general. If imports are possible, the recovery problems may not be as serious as in the more general attack. Also, the apparent importance of these severe bottlenecks tends to diminish when they are examined closely, and the possibility that they can be avoided by modest preparations often seems more likely. Both of these statements apply in the case of petroleum.

I now want to examine, very briefly, the question of how long it might take to restore gross national product to its prewar level after a thermonuclear war, assuming now that the reorganization problem can be solved -- that is, that the economy can be restored at least to the point where it is viable. (Needless to say, the question of the rate of recuperation is not reached unless there is reason to think that a cumulative decline can be avoided.) I also assume low levels of government expenditure. Rather than making specific assumptions on damage levels, I consider a situation where the full population survives and half the economy's capacity is destroyed. This is clearly unrealistic, but the relative balance between surviving industry and population is on the pessimistic side here, and the results of the following calculations in per capita terms depend only on the relative balance. This emphasis on the relative balance can be quite misleading when destruction levels are high, but not nearly so misleading in the present context as it is in the reorganization context. ■

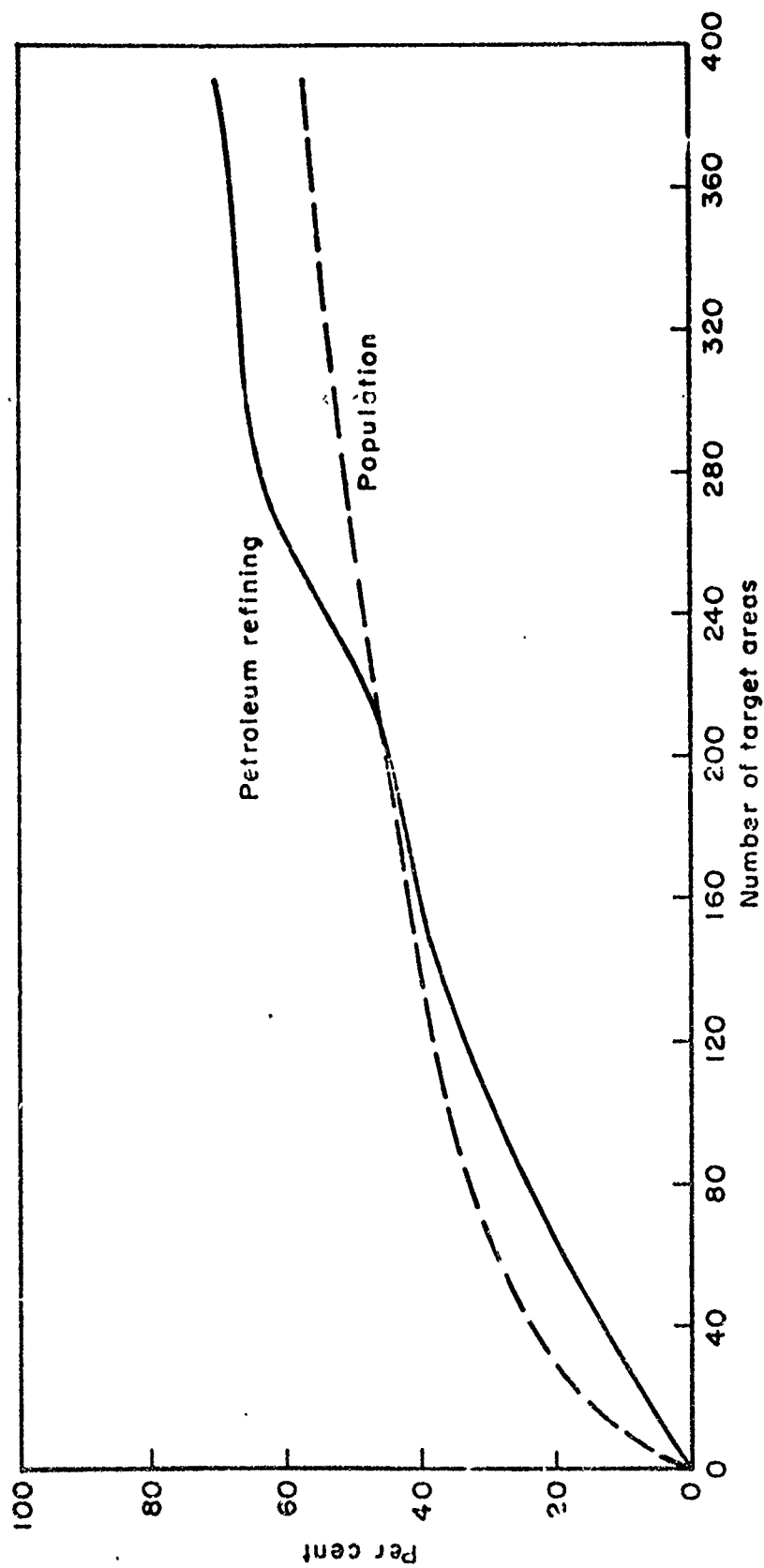


Fig. 5 — Concentration of resources — Population and petroleum refining

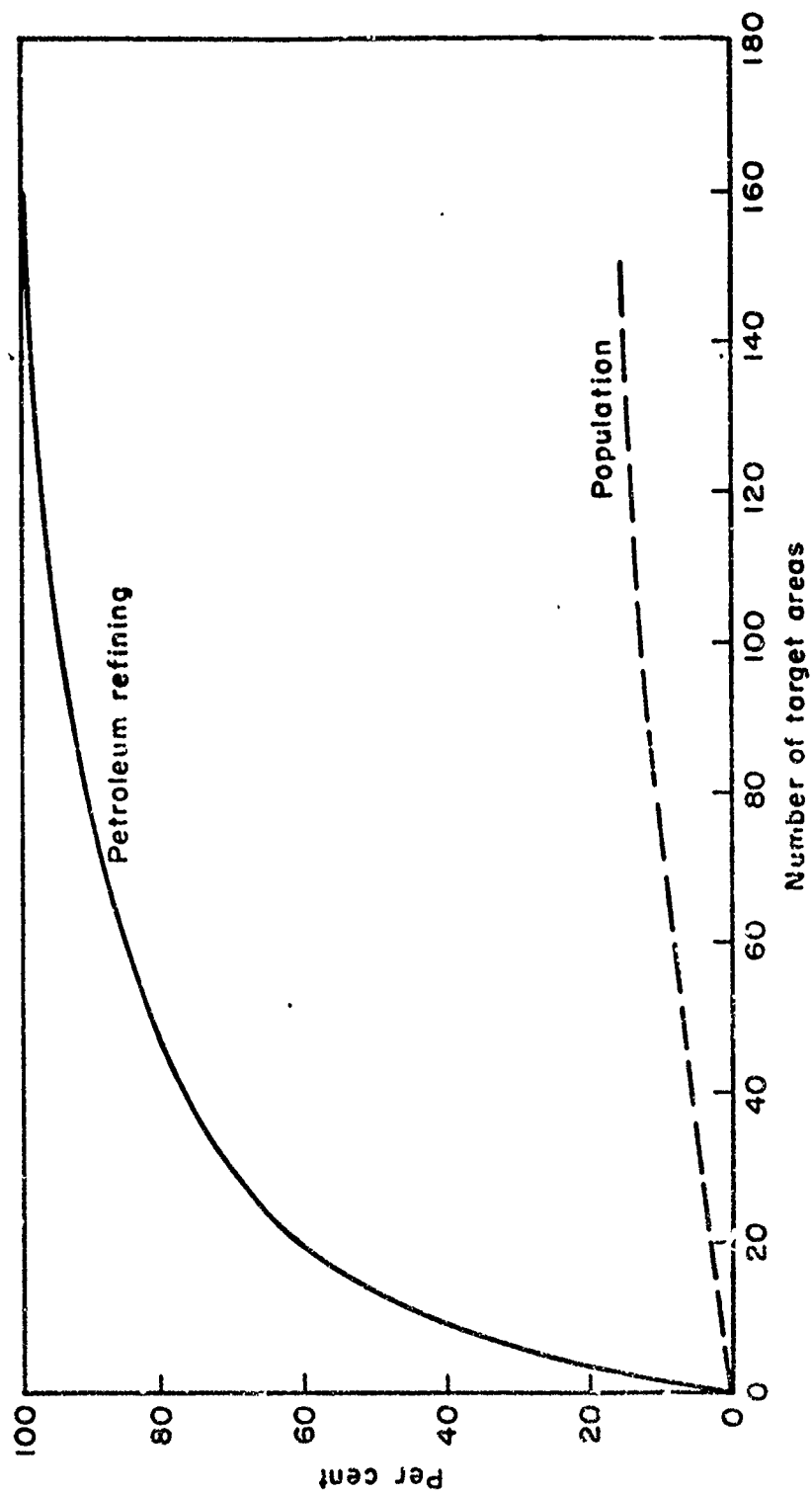


Fig. 6 — Concentration of resources — Petroleum refining and population

High destruction levels threaten the viability of the system, but if it is viable it is unlikely that much of the surviving wealth will be unutilized for long.

The following calculations are all in constant 1954 dollars, which correspond to about \$1.15 in current dollars. A reasonable estimate of gross national product at full capacity today, undoubtedly quite conservative for my purposes, would be about \$470 billion 1954 dollars. Assume half that capacity is destroyed, in such a way as to leave no severe bottlenecks in the portion that survives. Then a GNP of \$235 billion could be produced. The 1929 level of per capita consumption would be about \$1,000 in these terms; for a population of 180 million that means consumption expenditures of \$180 billion. I then allow a scant \$15 billion for government expenditures. A further allowance must be made for replacement of capital, used up in meeting these requirements; I estimate this as about \$17 billion. This uses up \$212 of the \$235 billion. The remaining \$23 billion can be allocated to creating new capacity, and, of course, to maintaining itself. If consumption and government expenditures are held constant, the new capacity constructed and the uncommitted old capacity can then be used to produce still more capacity, and so on in a cumulative way. The question then comes down to what the growth rate of this "uncommitted" capacity is likely to be. I think most economists would agree that, given the assumptions of no bottlenecks and the conditions of labor surplus, a growth rate of 25 per cent of this uncommitted capacity per year would not be unreasonable. In technical jargon, after an adjustment for depreciation, the 25 per cent growth rate would imply a capital-output ratio of about 3. If this assumption is valid, it turns out that capacity is back to the \$470 billion level in just over a

decade. This, once again, simply illustrates how very far we are from having a bare subsistence economy. If the calculations are repeated for the case where consumption standards are held at the level of the turn of the century, roughly \$700 per capita at 1954 prices, an allowance can be made for \$40 billion of government expenditures and capacity will be fully restored in 7 years.

These calculations are in no sense a proof of the feasibility of economic recuperation in about a decade. They are much too rough and aggregative for that, and many of the most important effects of a thermo-nuclear war are left out of account -- for example, the changes in agricultural practices required by contamination of farm land, the probability of severe bottlenecks in at least some industries, possible physiological and psychological effects on the efficiency of the work force, and so on. The very important assumption that reorganization is successfully accomplished has been made. Finally, there is the fact that the economic policies assumed are recuperation-oriented in the extreme. It is not at all clear that such a high valuation would be placed on rapid recuperation as compared with increasing consumption. But the calculations do show that recuperation in a period on the order of a decade is probably not physically infeasible by a large factor. Important as all the qualifications to these simple calculations are, they are not nearly so important as the difference between the American economy and that of an underdeveloped country when it comes to estimating the implications of substantial losses of productive capacity.

Let me summarize my statement briefly. The problems of economic recovery are complex and numerous, and many are inadequately understood.

There is a great need for further research in order to reduce or eliminate the uncertainties that now exist. There is a particular need for more supporting research on the social and psychological aspects of recovery, and on the effects of the changed physical environment on agriculture, since firm conclusions on the economic questions cannot possibly be reached as long as these other questions are not settled. Of course, many of these other questions also turn on how the economics comes out, so there is a need for a complete and integrated study of the whole problem. However, our current knowledge of the economic aspects suggests quite strongly that the difficulties of economic survival, reorganization, and recuperation need not be significant compared with the immense direct consequences of the war. I say "need not" rather than "are not" because I feel that many relatively cheap measures of preparation would have to be taken before the feasibility of reorganization could be asserted with much confidence. Many relatively cheap measures might make a very large difference in the outcome. Finally, I should state that these conclusions cannot be drawn with confidence with respect to the threat levels of the late 1960's, nor can they be applied to possible future situations when extensive systems of blast shelters might be available. Very large attacks, or much greater survival of population relative to resources, would increase substantially the relative significance of the economic recovery problem. Feasible preparations for economic recovery could reduce the relative significance of the problem to its present level. But very large programs of stockpiling, and of industrial dispersal and protection would probably be required to accomplish this.